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Impact of reduced sea ice in the Barents/Kara Seas on NH winter atmospheric circulation in a Seasonal Prediction System

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The sea ice cover in the Arctic Ocean has experienced an ongoing loss in volume and extent in the last decades, with recognized consequences for northern hemisphere atmospheric winter circulation. According to climate model projections this loss is going to continue. Sea ice is an important component in the global climate system owing to its properties: 1) it acts as an insulator between ocean and atmosphere, therefore hindering fluxes of energy, mass and momentum, 2) it has a high albedo and thus its presence strongly modifies the surface radiative budget, also through changes in the long-wave radiation emitted by the surface, 3) phase changes related to freezing and melting processes alter the vertical stability characteristics of the water column (via heat and fresh-water fluxes) affecting the ocean
circulation.

The Barents/Kara (B/K) Seas is the part of the Arctic Ocean experiencing the largest interannual variability and the largest loss in sea ice concentration (SIC) since the start of the observational period. Observational and modelling results point to increased surface heat fluxes from the ocean to the atmosphere, increased surface temperatures, and a reduced meridional surface temperature gradient in response to negative SIC anomalies, with far-reaching effects including changes in the NAO and the eddy-driven jet stream a few months later. This implies a transitional character of the response, from immediate local changes in surface fluxes (affecting atmospheric stability) to a delayed remote response in the atmospheric circulation.

On a seasonal time scale, Arctic sea ice concentrations in autumn have shown to be a source of predictability for the winter Euro-Atlantic climate in observational data. In particular, recent results suggest a stratospheric pathway in which autumn Arctic sea ice anomalies modify the upward propagating planetary waves that effect the strength of the stratospheric polar vortex, and subsequently determine the tropospheric response in late winter.

Here, this mechanism is investigated further using a fully-coupled seasonal prediction system by implementing a negative SIC anomaly in the Barents/Kara Seas lasting the whole month of November in the B/K Seas. This season is chosen because in this time of the year the surface fluxes between ocean and atmosphere are strong and the observed interannual variability in that area is largest. Preliminary results indicate a surface climate that resembles the one of a typical minimum year in terms of sea ice cover in the B/K Seas as described above. A downward-propagating signal from the stratosphere to the troposphere can be detected in late winter, thereby confirming previous results of a stratosphere-troposphere coupling in shaping the above-mentioned late-winter response.